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Tactical Unit Data and Decision Requirements for Urban Operations

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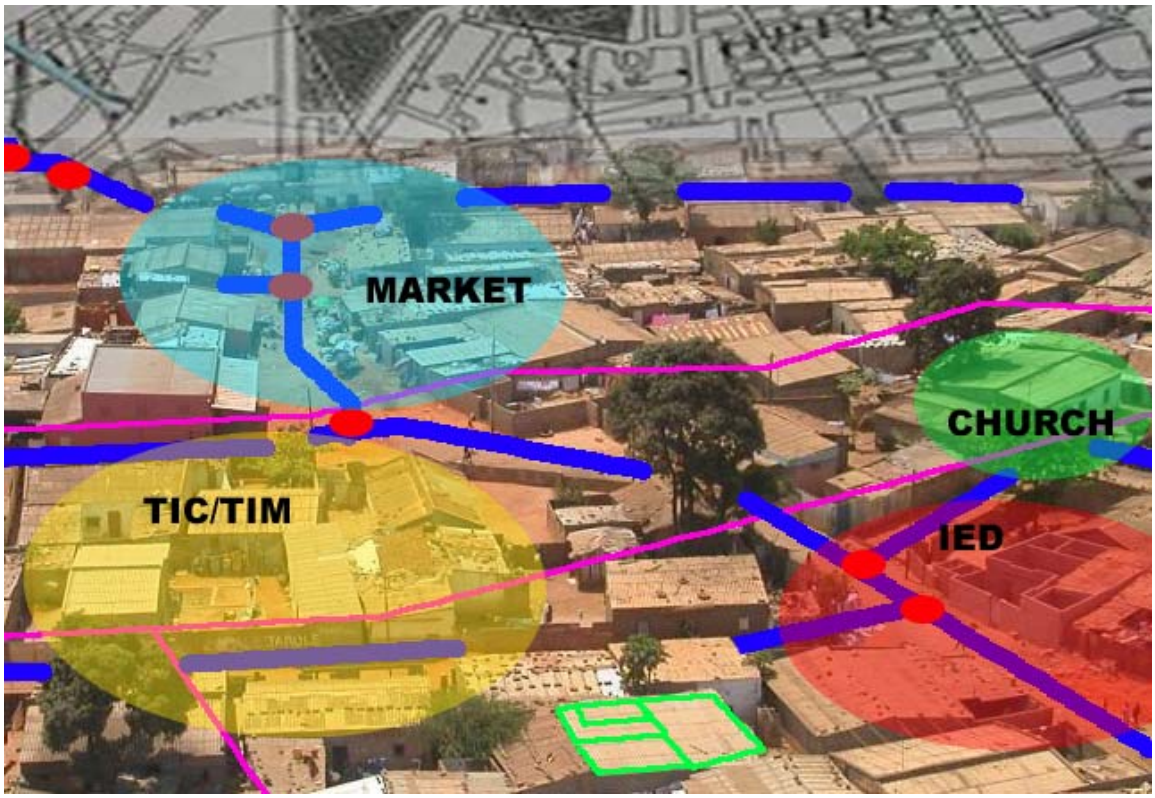
October 2008



Construction Engineering
Research Laboratory

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Construction Engineering Research Laboratory (CERL)
U.S. Army Engineer Research and Development Center
2902 Newmark Dr.
Champaign, IL 61822-1076

Final Report

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Abstract: The Future Force needs to dominate the urban battlespace to the same degree that the current force dominates open terrain. Warfare is now only one part of the spectrum of actions in which military forces become involved; the follow-on peace support operation and transition phase continue many years later. Success in these areas will necessarily rely on how well the urban environment can be characterized and modeled in terms of population, terrain, and infrastructure, and how well this information can be brought to tactical commanders in a decision support tool for mission planning.

The Urban Reasoning and Battlespace Analysis (URBAN) Army Technical Objective (ATO) of the Engineer Research and Development Center (ERDC) was funded to research and develop innovative tools to characterize the urban environment, model aspects of that environment as it relates to operations (maneuverability, sensor optimization, weapon effects, terrain), and develop rich but lightweight information structures and architecture. Specifically, the goal is to develop the ability to use automated prediction, pattern recognition, and reasoning and decision support tools to understand the battlespace environment in a collaborative network-centric environment. The objective of this research was to collect information about tactical unit data and decision requirements useful in urban operations.

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Preface

This study was conducted for the Engineer Research and Development Center (ERDC) as part of the Network Enabled Command and Control (NEC2)/Urban Reasoning and Battlespace Analysis (URBAN) Army Technical Objective under Army project AT41, "Military Facilities Engineering Technology," Work Units K672D3, "Building Characterization;" and 6183KF, "Cultural Awareness;" and project AT45 "Energy Technology Applied to Military Facilities" Work Unit B81D94, "Utilities Characterization." This work was funded by Headquarters, U.S. Army Corps of Engineers. The technical monitor was Mike Collins, URBAN ATO Manager, ERDC, Topographic Engineering Center.

The work was performed by the Facilities Maintenance Branch (CF-F) of the Facilities Division (CF), and the Business Process Branch (CN-B) and the Land and Heritage Conservation Branch (CN-C) of the Installations Division (CN), of the Engineer Research and Development Center's Construction Engineering Research Laboratory (ERDC-CERL). The CERL Principal Investigator was Jeffrey A. Burkhalter. The associated Technical Director is Kevin Backe, CEERD-TG-A. The associated Program Managers are Mike Collins, CEERD-TR-T and Kirk McGraw, CEERD-CV-T. Donald Hicks is Chief, CF-F, Michelle Hanson is Chief, CN-B, and Manroop Chawla is Acting Chief, CN-C. Michael Golish is Chief, CF and Dr. John Bandy is Chief, CN. The Director of CERL is Dr. Ilker R. Adiguzel.

CERL is an element of the U.S. Army Engineer Research and Development Center (ERDC), U.S. Army Corps of Engineers. The Commander and Executive Director of ERDC is COL Gary E. Johnston, and the Director of ERDC is Dr. James R. Houston.

Unit Conversion Factors

Multiply	By	To Obtain
acres	4,046.873	square meters
British thermal units (International Table)	1,055.056	joules
cubic feet	0.02831685	cubic meters
cubic inches	1.6387064 E-05	cubic meters
cubic yards	0.7645549	cubic meters
degrees Fahrenheit	(F-32)/1.8	degrees Celsius
feet	0.3048	meters
gallons (U.S. liquid)	3.785412 E-03	cubic meters
inches	0.0254	meters
miles per hour	0.44704	meters per second
ounces (mass)	0.02834952	kilograms
ounces (U.S. fluid)	2.957353 E-05	cubic meters
pints (U.S. liquid)	4.73176 E-04	cubic meters
pints (U.S. liquid)	0.473176	liters
pounds (mass)	0.45359237	kilograms
quarts (U.S. liquid)	9.463529 E-04	cubic meters
square feet	0.09290304	square meters
square inches	6.4516 E-04	square meters
square miles	2.589998 E+06	square meters
square yards	0.8361274	square meters
yards	0.9144	meters

1 Introduction

Background

The Future Force needs to dominate the urban battlespace to the same degree that the current force dominates open terrain. It is estimated that by the year 2015, over half of the world's population will live in urban areas (United Nations 2005). The large growth in population in urban areas, from mega-cities to large towns, has significant implications for future military operations. The Defense Science Board noted in 1996 that "the rapid growth of the number and size of urban centers, especially in regions of political instability, increases the likelihood that U.S. forces will be called on to conduct MOUT" [Military Operations in Urban Terrain] (Defense Science Board 1996). The Army writes in Field Manual (FM) *Combined Arms Operations in Urban Terrain* that urban areas are expected to be the future battlefield and thus, combat in urban areas cannot be avoided (U.S. Army 2002). To fully understand the nature of urban operations, one must also consider that warfare is now only one part of the spectrum of actions in which military forces become involved. Traditional attritional war has been replaced by the Understand, Shape, Engage, Consolidate, Transition (USECT) operation, where the warfighting component makes up only a small part. Typical of this kind of operation is the recent Iraq war, in which the high-intensity campaign lasted only a few months, but the follow-on peace support operation and transition phase continue many years later. Success in these areas will necessarily rely on how well the urban environment can be characterized and modeled in terms of population, terrain, and infrastructure, and how well this information can be brought to tactical commanders in a decision support tool for mission planning.

The Urban Reasoning and Battlespace Analysis (URBAN) Army Technical Objective (ATO) of the Engineer Research and Development Center (ERDC) was funded to research and develop innovative tools to characterize the urban environment, model aspects of that environment as it relates to operations (maneuverability, sensor optimization, weapon effects, terrain), and develop rich but lightweight information structures and architecture. Specifically, the goal is to develop the ability to use automated prediction, pattern recognition, and reasoning and decision support tools

to understand the battlespace environment in a collaborative network-centric environment. The result will be software and methodologies to help characterize the Urban-Battlespace Environment (U-BE), information structure and systemic architecture that enable sharing common data in near real-time, and mission planning and analysis software for U-BE decision support.

Characterizing the urban environment and presenting operational data for mission planning and decisionmaking in a useful structure is crucial for successful U-BE operations. However, much emphasis has been placed on developing decision and battle planning aids at the brigade level and above. Little focus has been placed on the leadership and command elements at and below the battalion level. The company, platoon, and squad leadership also have detailed planning to perform and require decision aids that can assist them in the dynamic urban environment. Furthermore, the requirements for these aids have not been well established, and the decision process and data requirements these leaders use in mission preplanning and execution is not well defined in the construct of a future computer-equipped force.

The research and development efforts within the URBAN ATO stem, in part, from information and data that are needed by U.S. forces for successful urban operations. Examination of field manuals; documents on tactics, techniques, and procedures (TTPs); and Soldier reports serve to begin the process of understanding unit forces needs. However, a deeper understanding of data and decisions about the urban environment useful in mission planning at the tactical level is needed. A research effort within the URBAN ATO was carried out at the Engineer Research and Development Center, Construction Engineering Research laboratory (ERDC-CERL) to study the data and decisions of units in tactical mission planning.

Objective

The objective of this research was to collect information about tactical unit data and decision requirements useful in urban operations. Of importance was learning what aspects of the physical urban environment are useful and/or critical to know for successful mission planning, how data is collected, and to what extent this information is part of the decision process for tactical leaders and affects success for combat, stability, and support

operations. The objective was to collect this urban environment information for mission planning efforts as well as for dynamic re-planning during mission execution. It is expected that knowledge of urban operations data and decision requirements can inform components of the URBAN research and development efforts, including efforts to characterize the urban environment (buildings, utilities, cultural activities, and terrain features), develop improved information constructs (data structures and architecture, fused information, compact and knowledge-rich data), and new decision support tools (analyses of mission, threat, and terrain, maneuver, weapon effects, and sensor placement).

Approach

Because the objective of this effort is to establish the decision support requirements for urban operations related to the URBAN research thrusts, it is vital to establish the linkages between the basic research areas and the tactical components of Army operations. To accomplish this, a matrix was developed to cross-reference the two. First, each of the URBAN research areas was arrayed vertically and organized by research theme (Characterization, Decision Support, etc.). Next, placeholders for three different military mission types were arrayed across the top matrix row. Since the actual military scenarios were yet to be created, these were simply named combat, peacekeeping, and reconstruction. At this point, the matrix cells were filled in by explicitly defining how each of the research thrusts is expected to contribute to the planning and decision support requirements of the various mission types. This process was begun by the military scenario development team then reviewed by the project leads for each specific research thrust. The result was a matrix that serves as a guideline for establishing critical planning and decision factors in urban operations while providing a benchmark for the research community to ensure their products address U.S. Army needs. The matrix listed in Table 1 reflects the URBAN research areas relationships to the planned use-case scenarios. The matrix also provided a basis for directing the development of questions to ask focus group participants so that their responses could inform the URBAN research efforts.

Table 1. URBAN military use-case scenario matrix

Lab	URBAN Research Thrusts	Scenario 1 Seize Insurgent Leader	Scenario 2 Food and Water Distribution	Scenario 3 Repair Power Substation
CERL	Cultural Ontology	Expected movements of locals/insurgents	Where crowds could form and likely queue lines	Family clusters and likely power sharing
	Utility Network Characterization	Where to cut the power for the target	Identify power supply for restoring at a single location	Identify connection points for substation and transformer locations
	Predict Building Function	Verify mosque and identify possible schools or meeting places	Identify types of cinema (stage/theatre) or other similar nearby structures	Identify other structures not in the immediate compound that house electrical equipment
	Building Interior Characterization	Determine mosque and residential floor plans	Interior layout of cinema and high-rises	Layout of power control facilities
GSL	Improved Dismounted & Mounted Mobility Models	Force composition, movement times, route plan	Time to establish site and route planning	Equipment requirement, movement times, and route planning
	Structures and Weapons Effects	Weapon requirements and impact on mobility	Weapon requirements	Weapon requirements
CRREL	Sensor Placement Optimization	Monitor insurgent movements	Monitor crowd clusters	Security monitoring with limited personnel
TEC	Semi-automated extraction of solid-geometry building models from tactical LIDAR	Build 3D models of neighborhood environment for mission planning	Enhance Line of Sight (LOS) determinations for security measures	Enhance LOS determinations and accurately model power complex buildings
	Persistent autonomous analysis and rapid resynchronization	Navigation through narrow streets and persistent direction finding	Navigation through narrow streets and persistent direction finding	Navigation through narrow streets and persistent direction finding
	General elevation data to mimic high resolution DEMs and eliminate date redundancy	Enhance LOS determinations for security measures	Enhance LOS determinations for security measures	Enhance LOS determinations for security measures

Scope

Given the comprehensive nature of the task, the scope of this effort was narrowed based on the limitations of available resources and to limit the focus of the research to a manageable level. For each of the approaches outlined above, several limitations were put into place. The literature review specifically focused on published standards and doctrine. In an age of web logs and informal memorandums, numerous opinions are available regarding the suggested methods and requirements for decisionmaking in urban operations. However, to ensure the methods were accepted Army policy, only official publications of field manuals (FM), TTPs, etc., were considered. In addition, articles published on Department of Defense (DOD) websites, such as the Center for Army Lessons Learned (CALL), or by Department of Defense (DOD) organizations, such as the Foreign Military Studies Office (FMSO), were also incorporated in the literature review process.

The focus groups were planned with a limited scope in mind. The group members were required to have deployed to theater and participated in operations in the urban terrain. Although it was expected most available personnel would have served in Iraq or Afghanistan, it was not a requirement due to the various Security, Stability, Transition, and Reconstruction (SSTR) operations conducted worldwide.

The survey was intended to be limited only by the number of people who could complete it. The survey was to be distributed across various Military Occupational Specialties (MOS) and among Active Duty, Reserve, and National Guard troops. Furthermore, input from other services with experience in urban operations, such as the Marine Corps, would also be considered within the framework of problems relevant to the Army.

Mode of Technology Transfer

This study serves to inform the research projects being conducted within the URBAN ATO and related efforts in the broader research environment. The results of this study will be transferred to the ERDC and to the Army by technical report. The information in this report will also be transferred to the field through presentations at appropriate symposiums and group meetings. This report will be made accessible through the World Wide Web (WWW) at URL: http://www.cecer.army.mil.

2 Scenario Development

To evaluate each of the research components in the matrix, three military scenarios were developed using the Three Block War concept (Krulak 1999). This concept suggests that all military operations fall into one of three areas: combat, stability and support operations (SASO), and reconstruction. However, since the time of the scenario development, the last two categories have been combined into SSTR. Although the URBAN research project is not directed at geo-specific solutions, a real-world location was chosen to lend realism to the scenarios. In this study, the city of Baku, the capital of Azerbaijan, was chosen based on the following attributes: variety of urban infrastructure, variety of urban cultural inputs, availability of geospatial data, and it is not a current focus of U.S. military combat operations. Baku is a city of roughly 2 million people (State Statistical Committee 2006) and is an ancient city that was developed by western nations in the late 1800s and also developed under Soviet rule from 1920 to 1993. These influences provide a variety of urban infrastructure and create a diverse cultural experience. To narrow the scope of scenarios, a single neighborhood was selected. The neighborhood, Akhmedli, began as a separate city, but was eventually absorbed by the urban sprawl of Baku. Akhmedli was chosen due to its definable borders, ancient street patterns, and adjacency to major roads, cultural sites, and modern high-rise developments. These characteristics provided a well-defined region for the scenarios and enabled operations using Battalion or smaller units. Due to the limited size of the focus area and smaller unit sizes, the frequency and duration of the missions could be limited to better identify the 2nd and 3rd order impacts of decisions made in the urban environment. These components helped shape the individual scenarios used in this study.

The scenarios were developed in the context of a larger peacekeeping and humanitarian aid mission. A brigade combat team was deployed to conduct SASO following a military coup attempt that has disintegrated the Azerbaijani government and left the country in general anarchy. The Army has deployed in an effort to protect the lives and democratic rights of the populace, and to preserve the infrastructure and access to natural resources.

The first scenario, a combat mission, was oriented towards 'low-intensity' conflicts. Rather than using an example of a combat mission against a regular fielded army, this scenario uses irregular enemy forces, such as commandos or insurgents. This was used to determine information needs in asymmetrical warfare, which presents unique challenges, especially in the urban environment. The mission of this scenario is to cordon the Akhmedli neighborhood with the intent of seizing an insurgent leader purported to be residing there. In addition, subordinate tasks include clearing the neighborhood of other insurgents and weapons caches.

The second mission involves conducting humanitarian aid in the form of distributing food and water. The company is tasked with distributing these items to the residents of the Akhmedli neighborhood. Civil affairs personnel have been attached to assist in the coordination and a military police company is attached to assist with providing security. This scenario takes place a couple of weeks after the first scenario, so the results of the combat mission will impact local opinions.

The third and final mission consists of conducting repairs to the local power substation with the intent of restoring regular electrical service to the neighborhood. The commander has a large bulldozer as extra equipment, but no additional security elements. Furthermore, this mission is being conducted on the same morning as the food and water distribution.

These three scenarios were developed in concert with the research matrix to provide realistic, relevant missions to coordinate and evaluate URBAN product development.

3 Data Collection

Data regarding decision support requirements in urban operations was planned to be collected using three methods: literature review, focus groups, and a survey. The literature review was to be performed by searching historic urban combat operations and current doctrinal guidance. The focus groups would be selected from available U.S. Army Soldiers with recent experience conducting urban operations in Iraq and Afghanistan. Finally, the survey would be made available to a variety of Soldiers who had experience in conducting missions in the urban terrain. It was expected that these data collection methods would result in a representative cross-section of decision support needs for Army commanders and staff planners.

Literature Review

Following the development of the scenarios, literature was reviewed to establish current doctrine and practices that might inform the decision support needs of commanders and staff planners. Several key sources were used in this process. The first key source is the Center for Army Lessons Learned (CALL). CALL hosts a number of literature sources ranging from formal journal publications to informal web log inputs. CALL's principal source information came from Operation Iraqi Freedom (OIF), Operation Enduring Freedom (OEF), and the FMSO. The OIF and OEF data sources are primarily made up of updated Tactics, Techniques, and Procedures (TTP) documents and other commentaries on the state of military practices in the urban environment encountered in those theatres. Although a heavy emphasis was placed on evaluating current practices, the URBAN project seeks to develop decision support mechanisms that are effective in any geographic location, so care was taken to evaluate other influences. This is where the FMSO was valuable. The FMSO posted articles written by military historians on past urban combat operations, many of which did not include the participation of U.S. Armed Forces. These articles helped evaluate practices and environments with which U.S. service personnel are unfamiliar. For example, the FMSO published a series of articles on the Russian experience in Chechnya, highlighting the struggle to control the city of Grozny. In fact, it was discovered that a number of the specific challenges the Russians faced were repeated by the U.S. Armed Forces in the first few years of OIF.

In addition to the resources from CALL, other Army doctrinal publications such as FMs, Army Training and Evaluation Plans (ARTEP), and past TTPs were reviewed. These documents helped establish the doctrinal origins of current practices and the military decisionmaking process in urban terrain. Last, the Marine Corps Center for Lessons Learned (MCCLL) was reviewed for relevant documents in urban operations. The Marine Corps has been tasked with many of the same missions as the U.S. Army in OIF and OEF, and employs similar tactics with similar weapons systems. The data from these sources were used both to validate the reality of the scenarios and to determine what sorts of decision support needs exist for commanders and staff planners in urban operations.

Focus Groups

Two separate focus group studies were conducted with U.S. Army Soldiers experienced in urban combat and peacekeeping operations. Both focus groups were conducted with Army National Guard Soldiers who had recently returned from overseas deployments in support of OIF and OEF. National Guard Soldiers were used for the focus groups due to their proximity to the researchers' facilities and their availability for time to contribute to the groups.

There are numerous methods for designing the organization of the focus group. Two primary questioning strategies are typically used: the topic guide and the questioning route (Krueger 1998). To ensure the consistency and precision of the questions, the questioning route was selected. The questions were prepared and organized by hand, without the assistance of computer software. The general organization of the questions was aligned with each of the basic research topics in URBAN. Using the matrix, elements of each research area that contributed to the particular mission scenario were developed into a set of questions. These elements were deconstructed into topics and themes, each of which had an established set of questions. The question set included both primary and follow-up questions. Figure 1 illustrates the organization of the questions for the focus groups.

The moderator functions were conducted by a team member/discussion leader who also performed the tasks of the writer. In addition, the moderator was supported by a technical expert to assist with fielding more complex technical questions.

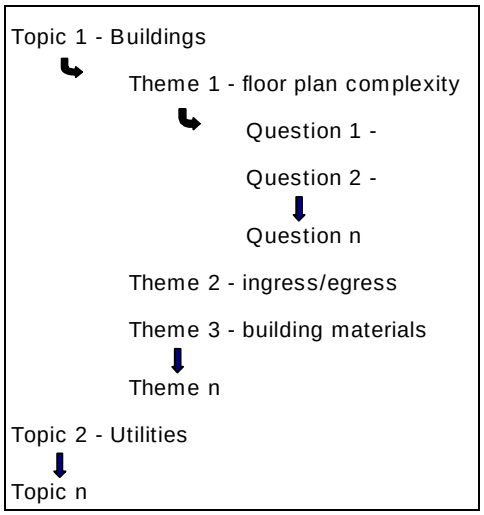

Figure 1. Organization of questions by research area.

Interviewed Groups

Four separate focus groups were conducted on two separate occasions. The first three focus groups were conducted in January 2006 with representatives of the 76th Infantry Brigade of the Indiana National Guard. Members of the 76th Infantry Brigade were deployed to Iraq and Afghanistan in support of OIF and OEF. Originally, it was expected to have four groups, two each of officers and non-commissioned officers (NCOs). It was intended to separate the groups by rank to ensure complete freedom of expression and to gather the different perspectives each rank group might bring. However, due to personnel and time constraints on the part of the 76th Infantry Brigade, this arrangement was modified on the day of the session. The representatives were divided into three separate groups: one group of officers, one group of NCOs, and one mixed group that included both officers and NCOs. Each focus group had a time limit of about an hour, so it was determined that each group would focus on one particular scenario. For example, group one would focus on scenario one, group two would focus on scenario two, etc. However, the third group moved quickly through scenario three, and used the extra time to revisit some of the questions from scenario one.

The fourth focus group was conducted in May 2006 with representatives from the 2nd Battalion, 130th Infantry Regiment of the Illinois National Guard. Recently returned from a deployment to Iraq in support of OIF, its members had considerable experience conducting missions in the urban terrain. This group was of mixed rank, including both officers and NCOs. Representatives included Soldiers involved in direct mission execution,

logistical support functions, and battalion staff planning efforts. Soldiers in attendance have an MOS in the areas of: infantry, maintenance, quartermaster, and NBRC (nuclear, biological, radiological, and chemical). Due to greater time availability, this group was questioned on all three scenarios.

Data Compilation

The four focus group discussions provided numerous notes and comments on the conduct of missions in the urban terrain and the decision support needs that best support commanders and staff planners. However, to adequately develop the results of these discussions, the responses needed to be categorized and evaluated for validity, duplicity, and specificity. In terms of validity, it was important to ensure that the responses actually answer the question asked and apply towards the specific research areas with which URBAN is concerned. In terms of duplicity, it is necessary to combine responses that say similar things, both as a way to organize the data and to assign some weight to the comments provided. In terms of specificity, the responses must be evaluated to ascertain whether they are too specific for a particular kind of mission, mission parameter, or geographic region of the world.

Following the initial data review, each of the responses was categorized into the area(s) of URBAN research that it contributed information. The resulting data was used to determine critical decision points in mission planning and execution, assist in determining what future decision support needs commanders will have in urban operations, and to assess the overall validity of the URBAN research efforts against the metric of real experience by the first-line operators of any resulting research products.

4 Results

General Results

The results from the focus groups and the literature search revealed numerous elements that detail the potential role of decision support systems in urban operations. The gathered elements were collected and organized by the respective URBAN research area. From these individual components several general observations were deduced that will provide a good perspective when discussing results from the individual research areas. The general observations are listed below:

1. No doctrinal method exists for transition of data between rotating units (data collected by small units is 'at best' hardcopy).
2. Understanding of environment was through doing (building recon).
3. Decision support tools must be lightweight, simple, and efficient.
4. Time in place and en route is critical.
5. The Central Intelligence Agency's *CIA World Fact Book* (CIA 2006) does not constitute cultural awareness.
6. There is a need to better understand how to disrupt enemy without interrupting civil affairs efforts.

The first observation is that no standardized method exists for transitioning data about specific urban areas of operation. Given the large amount of qualitative and quantitative data gathered by a unit over a 6- to 12-month tour, it is difficult to catalog or pass on this data to a relieving unit without a well-defined process. Current methods of transition include practices designed to familiarize incoming units with the local area of operations. However, these practices do not include the transition of electronic data that may aid the planning and decision process by future commanders.

Second, understanding of the urban environment was not supplemented by detailed data about the built environment and cultural components. Understanding was gained only through doing, or by executing missions and slowly gaining familiarity with the people, places, and practices of the area of operations (AO).

Third, any decision support tools developed for use at company level or below must be lightweight, simple, and efficient. Soldiers commented that the current combat load of equipment did not allow either the space or

weight for anything other than a small device. Also, the tempo of urban operations necessitates a simple device than can provide relevant results quickly. Last, the current consumption rate for batteries is significant, so additional hardware devices must stress efficiency.

Fourth, some of the key aspects to planning operations in the urban environment are the time in place and time en route. Due to the ease with which forces can be observed, it is critical to enable planning that will minimize travel time and maximize effectiveness during the limited time in situ.

Next, decisions requiring a basic understanding of the cultural context of the AO inevitably reference the *CIA World Fact Book* (CIA 2006). Although the Fact Book is an excellent at-a-glance reference to gain a very basic familiarization with the country under investigation, it was not intended to serve as a detailed cultural resource. The basic demographics contained in the Fact Book are unable to capture the uniqueness of the various cultural components and how their daily activities may impact military operations. A lack of understanding of the cultural details of daily life was described as a significant limitation in effectiveness.

Last, modern conflicts are more often tied together with humanitarian or peacekeeping efforts. An area of understanding that must be developed and bridged is how to conduct effective combat-oriented operations in the urban environment without disrupting or derailing stability, support, and reconstruction efforts.

Detailed Results

The detailed results from the literature search and the focus groups were organized based on the various components of the URBAN research effort. As described earlier, URBAN consists of research in the areas of: characterization of the urban environment, decision support tools for the urban environment, and advanced information constructs. Since the scope of this investigation focused on the first two, these were further divided into their subcomponents for reporting the results. Characterization of the urban environment consists of the following components:

- Buildings (specific and typecast)
- Utilities networks and systems
- Cultural (cohorts and activities).

Decision support tools for the urban environment consist of the following components:

- Maneuver modeling
- Sensor optimization (electro-optical, infrared, and acoustic)
- Weapons effects.

The following narrative will describe the critical elements of each of these areas as described by surveyed Soldiers and documented in Army publications.

Characterization – Buildings

The discussion related to the characterization of buildings refers to enclosed structures that support working and/or living spaces at all scales of structures. A clear understanding of the buildings is important to inform commanders to use or deny structures to the enemy, identify possible danger areas, and or develop safe and efficient movement plans through the urban battlespace. The research focus identified several important areas of interest.

The first area of interest is that data requirements for buildings in the urban environment are poorly defined. When the focus groups were queried about what information was necessary to understand a building, there was not a well-understood consensus of what that should be. There were difficulties in clearly establishing the critical traits of a structure between and amongst the focus groups. However, publications such as the *Urban Generic Information Requirements Handbook* (UGIRH), published by the Marine Corps Intelligence Activity (U.S. Marine Corps 1998), detail very specific information requirements for buildings. A logical conclusion is that the information requirements have been detailed among the intelligence community, but has not been briefed, trained, or expected of the typical Soldier, at least within Army organizations. The apparent lack of standardization makes cohesive data collection and comprehension more difficult.

For all of the described missions, determining a building's size, the number of stories, and number of rooms was identified by Soldiers as being critical information. Having the information pre-execution and during execution, reduces the time to perform the mission (e.g., search, clearing, etc.) and contributes to mission accuracy and success. It was expressed that determining the distance between buildings is also important, which

enables the identification of structures that can be reached by movement across rooftops. The ability to identify specific large open spaces within a building was also discussed as likely areas for ambushes.

The Soldiers indicated building function and adjacency are more critical than a building's interior layout. It was expressed that a building's exterior strongly indicated its function. Based on the use, much of the interior character of the building can be inferred. This is true except in the case of larger structures, where it is much more difficult to make inferences about the about the building's interior due to size and potential complexity.

Last, some information was desired regarding the structural components and capacity of a building. The composition of building materials would enable the Soldiers to make informed decisions about the effects of their weapons on occupants and non-combatants. Also, for medical evacuation planning, it is also important to determine if the roof of a building can support rotary wing aircraft.

From these standard characteristics, we can then draw conclusions for decisionmaking: e.g., time of day of occupancy; number and types of people occupying the building; building interior layout. Table 2 lists military mission needs as they relate to building attributes.

Table 2. Data Requirements for Building Characterization

Attribute	Usage
Building's size	To estimate the time required to clear
Number of stories	To estimate search/ clearing time
Number of rooms	To estimate search/ clearing time
Building's function	For smaller buildings, function paints picture of interior
Building interior layout (for larger structures)	Additional information needed for larger structures, due to size and potential complexity
Amount of dead space in buildings	To avoid likely danger areas within structures
Distance between buildings	To establish likely movement across rooftops
Building load capacities – for medical evacuations	For medical evacuation
Number/ type of people in the building	To plan an appropriate method of entry
Picture of the building	To quickly identify a specific structure and use

Characterization – Utilities

Assessing utility networks, especially in undeveloped or underdeveloped nations presents unique challenges. In many cases, only a sparse network exists, with little documentation and few knowledgeable operators. Furthermore, the limited service often provided to the populace necessitates a heavy reliance on local resources (such as generators for electric power), which limits the tactical effectiveness of controlling the utility systems. In addition, the lack of standardized documentation and understanding utility characteristics further hampers the planning of operations in the urban environment.

A principle concern of the focus groups was the ability to establish the connectivity of power sources. In other words, understanding the network was important to gaining knowledge about how particular structures and portions of the urban environment were connected to the utility networks. However, an accepted method of cutting utilities, such as power, was to simply destroy a link in the network. Although this achieves the tactical advantage, it limits rapid restoration of municipal functions, especially in SSTR operations.

Second, Soldiers indicated they needed documentation of utility networks. Critical elements identified included the routing of utility and power lines, and nodal points in the network. The ability to disconnect power, for example, enabled the concealment of night movements. Furthermore, the identification of overhanging lines and nodal points aided in the route planning process. Also, the need to shut down cell phone towers was expressed. Control of utility and communications systems assist in obtaining and maintaining operational control of the urban environment. Table 3 lists military mission needs as they relate to electrical utility attributes.

Table 3. Data requirements for utilities mapping.

Attribute	Usage
Substation locations	To identify main utility hubs
Vertical obstruction towers	To identify limits to Aeromedevac movements
Vertical obstruction lines	To identify limits to Aeromedevac movements
Local power distribution points	Establish locations to control power to select areas of the urban environment
Extent of government network vs. private networks	What portion of the utility system is maintained by the government vs. private or corporate interests?
Communication towers and power connection	Ability to temporarily disable local communications systems

Characterization – Cultural

Cultural understanding of the urban area is paramount in modern operations in both combat and SSTR environments. Soldiers expressed the need to understand the cultural components prior to or immediately on entering a new area. As units often shift assignments in the pre-deployment process or during a deployment, new areas are encountered that may possess cultural characteristics uniquely different than their original or previous assignments. In this regard, Soldiers expressed the need to gain better awareness of the cultural environment in their AO.

First, it was highlighted that basic demographic information was needed for a particular mission area. Information such as the ethnic groups represented in the area, and information about their culture (language, religious practices, customs, etc.), are vital at the neighborhood level. For example, in many cultures, when addressing the family, it is important to address the patriarch. Cultural characteristics such as the religious, social, and familial norms offer important considerations for military operations to apply knowledge of a group's activity to a specific location. For example, knowledge of market times, prayer times, festivals, school schedules, and seasonal road traffic patterns provide vital information about cultural patterns that can greatly affect the success of an operation. In addition, units need to have an awareness of cultural events such as holidays, festivals, memorials, and an awareness of culturally sensitive issues.

Currently, local interpreters provide critical support when communicating with the local populace. Soldiers indicated a need to capture some of the information that the interpreters possess. This was discussed as a twofold approach: (1) report format or documentation aid that would assist in recording information provided by the interpreter, and (2) electronic devices to passively capture the knowledge of interpreters. Last, an awareness of the number, extent, and outcome of previous missions, friendly and hostile, would enable more comprehensive mission planning perspectives. Table 4 lists military mission needs as they relate to cultural attributes.

Decision Support – Maneuver

Traditionally, the collection of data informing planners on how to improve maneuver in the battlespace has focused on open-rolling terrain. However, the density and rapid terrain transitions in urban areas dictates that the resolution and scale of collected data must be improved.

Table 4. Data requirements for cultural characterization.

Attribute	Usage
Common mannerisms	Are the mannerisms normal, or an indicator of something amiss?
Common dress based on time of day/year	Does the state of dress coincide with the cultural norm?
How people received goods	Will they accept donations? Will they stand in line? Will the stronger immediately steal from the weak?
Local traffic patterns	To assess impact of TCP's on local traffic networks
Market hours	To assess when people will likely be out shopping and when open markets will be active
Religious service times	To assess when scheduled religious observances will take place
Detailed demographics	Understanding social and cultural consistency of a neighborhood, identification of local leaders

With this in mind, Soldiers were queried about the type, frequency, and detail level of information needed to support maneuver decisions in the urban environment.

The first of the information pieces requested was a detailed understanding of urban pathways, with their capacity to handle various types of foot or vehicular traffic. In addition, limiting factors such as load capacity, passable widths, turn-around capacity, and corner clearance were all mentioned as important. Next, Soldiers expressed the need to be able to map threats on the route during pre-planning. For example, if particular characteristics of the built environment made an area suitable for Improvised Explosive Device (IED) placement, these should be identified and mapped where they occur on possible route choices. Also, they desired that threat updates could be made available dynamically. For example, if a demonstration had started on a route after movement began, the planning staff should be able to identify the location and send it via a map interface to the mission commander. The ability to map "real-time" intelligence is vital during the mission as well as prior to mission execution.

Decision Support – Sensors

The focus groups did not have significant experience employing sensors in the urban environment. However, they did express several key elements that effective sensor technology must possess. Sensors should be discrete, disposable, and dependable. Discrete was defined as the ability of the sensor to blend easily with the environment or go unnoticed due to size. Disposable was defined as a low-cost sensor that could be used and forgotten, and be easily rendered useless if recovered by opposing forces. Dependability was defined as the ability to maintain a consistent level of surveil-

lance over a specified time period in a variety of atmospheric environments. Although the majority of surveillance efforts were performed by personnel using scouting patrols and observations posts, a handful of sensor technologies were employed. Some military units employed camera sensors commonly used by the U.S. Marines. These sensors collected thermal and EO (electro-optical) images. In addition, some units had experience implementing aerostat balloons for surveillance. Both of these technologies had significant limitations. The camera systems were unreliable and costly to replace. The aerostat balloons were quiet, but were not preferred since they are easily spotted. Since the balloons must be tethered, their presence identifies the location of friendly forces.

Feedback from the focus groups indicated that the current Global Positioning System (GPS) tools in use fail most often during mounted operation rather than when carried or handheld during dismounted operations. This is important for future systems designs. The Soldiers indicate the graphic images are most helpful. 3D graphics are most preferred. Throughout the focus group sessions, the Soldiers reiterated the need for visual information (pictures of buildings, etc. to more easily identify them). Units currently transmit satellite imagery and a number system, and also PowerPoint sketches through the Blue Force Tracker (BFT) tool, which they have indicated works well. Any additional handheld devices should also be electronic, lightweight, not require batteries, have a good screen resolution, a quick refresh rate, have the ability to withstand dust, and require minimal training to use. Lack of these features was identified as causing problems in the past.

The ability to capture information about buildings, roads, utility networks, and cultural intelligence is critical. Better ways of getting visual information (preferably 3D images) about building structures to the Soldiers are needed.

Decision Support - Weapons Effects

Decision support information for the urban environment also has direct applications in research areas related to weapons effects. The first element of concern to Soldiers is the range and penetration capability of various munitions on typical urban structures. For example, the M2 .50 cal machine gun is an excellent weapon; however, its range and penetration capability make its rounds lethal over long distances, potentially endangering noncombatants and friendly forces elsewhere in the city. However, smaller caliber weapons, such as the M243 SAW (squad assault weapon),

do not have the ability to penetrate structural walls, which limits their effectiveness.

The second element of concern is the breaching ability of weapons and their effects on structures. Establishing the type and thickness of structural material in advance would ensure that the proper breaching munitions would be selected for the mission. In addition, the impact of breaching charges (blast, fragmentation, etc.) must be well known prior to use.

The last element of concern related to weapons effects and munitions selection was the overall humanitarian impact. As previously mentioned, larger caliber weapons with long ranges present the risk of unwanted casualties. However, weapons with a high level of stopping or explosive power are sometimes needed. Weapons like the MK19 40mm grenade launcher would seem to fit the criteria. However, the ammunition has a high 'dud' rate, which in effect generates a large quantity of unexploded ordnance (UXO) available to the local populace. Understanding the effect that the ordnance selection will have on the urban environment is a key component for effective decision support.

The feedback from available literature and the focus groups indicated a range of both specific and general information elements that should be incorporated into a decision support tool for the urban environment.

5 Summary and Recommendations

Summary

The increase in urban populations and the increase in asymmetrical warfare worldwide will increase the necessity for greater tactical intelligence and decision support in the urban environment. Research in developing decision support logic, analysis tools, and advanced information constructs through the URBAN program will seek to improve the existing deficit. A review of current DOD literature and focus groups with Soldiers highlights the need to better understand the urban landscape.

Recommended Improvements to the Research Process

Despite planning the objective, approach, and scope of the research process, it was observed that some improvements would make future efforts of this type a greater success.

The literature review covered the primary Army-sanctioned sources for planning operations in the urban environment. However, the relatively recent emphasis on the urban terrain resulted in few established publications. As a result, most of the relevant texts came from newly developed TTPs and articles posted on DOD websites. Furthermore, as the environment and the obstacles change in theater, new TTPs are being developed. Due to the Army publication process, however, much of these new tactics and decision support criteria are not yet available for review.

The focus groups provided an excellent venue to collect updated TTPs and gain a sense of the pace of operations. In addition, the groups revealed a cohesive picture of the planning and execution processes. However, each group related almost too specifically to their experiences and was less able to 'think outside the box.' The time and financial limitations of this effort precluded travel to and/or from active duty installations for either the researchers or focus group participants. The availability of local National Guard units with experience in theater resolved this issue. However, it remains to be seen if the experiences of Reserve or Active Duty Soldiers varied significantly from those in the National Guard. It was evident that the different deployment timetables from the different units involved revealed noticeable changes in tactics, equipment, and available intelligence. Furthermore, the vast majority of the personnel involved had a primary MOS

within the Infantry Branch of the Army. Although there were a handful of representatives with NBRC and logistics specialties, most of the Soldiers involved were infantry specialists.

Finally, a limitation for the survey process was the unavailability of single distribution point or proponent for the survey. The researchers would have to distribute the survey to personnel as they could due to the lack of a single proponent office that could disseminate the survey to a good cross-section of personnel in a timely and organized manner.

Acronyms and Abbreviations

Term	Spellout
AO	area of operation
ARTEP	Army Training and Evaluation Plans
ATO	Army Technical Objective
BFT	Blue Force Tracker
CALL	Center for Army Lessons Learned
CEERD	U.S. Army Corps of Engineers, Engineer Research and Development Center
CERL	Construction Engineering Research Laboratory
CIA	Central Intelligence Agency
CRREL	Cold Regions Research and Engineering Laboratory
DOD	Department of Defense
EO	electro-optical
ERDC	Engineer Research and Development Center
FM	Field Manual
FMSO	Foreign Military Studies Office
GPS	global positioning system
GSL	Geotechnical and Structures Laboratory
IED	improvised explosive device
LIDAR	Light Detection and Ranging
LOS	Line of Sight
MCCLL	Marine Corps Center for Lessons Learned
MCIA	Marine Corps Intelligence Activity
MOS	Military Occupational Specialty
MOUT	Military Operations on Urban Terrain
NEC2	Network Enabled Command and Control
NBRC	nuclear, biological, radiological, and chemical
OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom
SASO	stability and support operations
SAW	squad assault weapon
SOCOM	U.S. Special Operations Command
SSTR	stability, security, transition, reconstruction
TEC	Topographic Engineering Center
TNT	trinitrotoluene
TTP	Tactics, Techniques, and Procedures
U-BE	Urban-Battlespace Environment
UGIRH	Urban Generic Information Requirements Handbook
URBAN	Urban Reasoning and Battlespace Analysis
USECT	Understand, Shape, Engage, Consolidate, Transition
UXO	unexploded ordnance

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14. ABSTRACT

Future Force needs to dominate the urban battlespace to the same degree that the current force dominates open terrain. Warfare is now only one part of the spectrum of actions in which military forces become involved; the follow-on peace support operation and transition phase continue many years later. Success in these areas will necessarily rely on how well the urban environment can be characterized and modeled in terms of population, terrain, and infrastructure, and how well this information can be brought to tactical commanders in a decision support tool for mission planning.The Urban Reasoning and Battlespace Analysis (URBAN) Army Technical Objective (ATO) of the Engineer Research and Development Center (ERDC) was funded to research and develop innovative tools to characterize the urban environment, model aspects of that environment as it relates to operations (maneuverability, sensor optimization, weapon effects, terrain), and develop rich but lightweight information structures and architecture. Specifically, the goal is to develop the ability to use automated prediction, pattern recognition, and reasoning and decision support tools to understand the battlespace environment in a collaborative network-centric environment. The objective of this research was to collect information about tactical unit data and decision requirements useful in urban operations.

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